point of view of pure research or conservation but because it is only by the study of areas subject to little direct influence by humans that the nations of semiarid Africa will be able to establish land use planning criteria that will enable them to raise the standard of living of their rapidly expanding populations. In much of Africa meat from wild animals still provides up to 60 percent of the protein needs, yet understanding of the potential for harvesting the large herbivore communities on a sustained yield basis is still in its infancy. Financial support of the sort of research that was carried out on the Serengeti over the last two decades has now virtually ceased in spite of the fact that the research is still some way from producing predictive models that will be of general value.

The editors of this volume have drawn together a number of experienced ecologists who have attempted to view their research within the broad framework of the Serengeti ecosystem. The book represents one of the most complete and thought-provoking attempts to analyze an African grassland ecosystem to date and will be a valuable source for all students and researchers engaged in the study of ecology in the tropics. Above all, perhaps, we may hope that as a result of the appearance of this valuable volume the work of the Serengeti Research Institute will not die.

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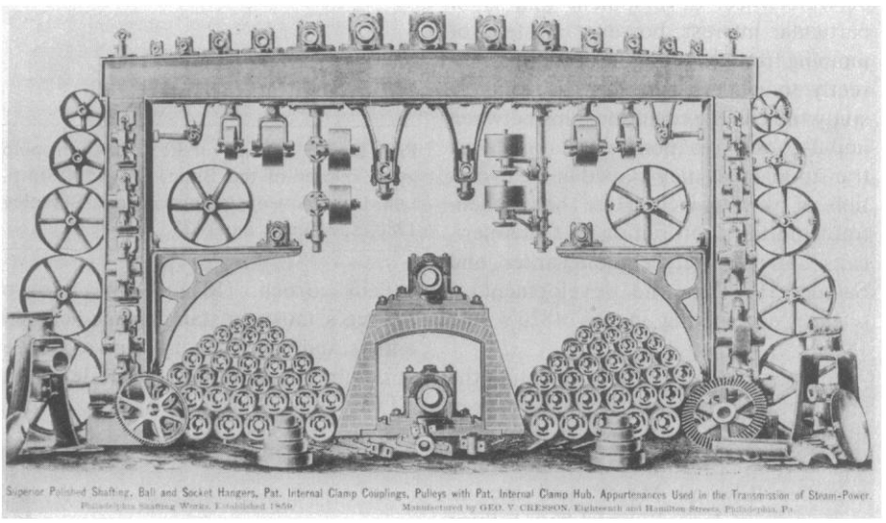
Waterpower

A History of Industrial Power in the United States, 1780–1930. Vol. 1, Waterpower in the Century of the Steam Engine. LOUIS C. HUNTER. Published for the Eleutherian Mills-Hagley Foundation by University Press of Virginia, Charlottesville, 1980. xxviii, 606 pp., illus. $24.95.

Louis C. Hunter's study of waterpower in the century of the steam engine is one of those landmark books that define a subject and in so doing set goals and standards for future work. The author traces the history of direct-drive waterwheels from the scattered rural mills of 200 years ago to the concentrated urban factories of the 20th century.

The strength of the study comes from Hunter's view of waterpower as a system composed of many parts. Unlike previous writers, who usually have limited themselves to description of the wheels, Hunter deals also with the dams and raceways that supplied them with water and the millwork that distributed the power generated to production machinery. Moreover, he weaves the tale of waterpower into the technological, economic, and cultural fabric of 19th-century society. As he grapples with developments of nationwide importance, his pen often dips into the ink of local history to lend his writing an immediacy that is lacking in the publications of the European and American millwrights and engineers that constitute his basic source materials. The book is a pleasing blend of generalization and detail interwoven in the exploration of the problems en-



A millwork manufacturer's advertisement of the 1870's (*The Manufacturer and Builder*, March 1875). Much earlier than in Europe, the traditional massive wheelwork gearing came to be replaced with belting in the United States. "At bottom the acceptance of this innovation . . . simply reflected the steady rise in machine speeds dictated by the drive for increased productivity and lower unit costs. . . . The success of belt drives and the ever rising speed of shafting that it made possible were owing in large part . . . to the redesign and systematic production not only of the shafting itself but of the auxiliary equipment ranging from hangers, couplings, and bearings to the pulleys and belts forming the first and final link between the motor and the machine." [From *A History of Industrial Power in the United States, 1780–1930*, vol. 1]

Piney Branch Mill near Fairfax, Virginia. "With the accelerating advance of industrialization from the 1840s and the progressive though gradual penetration of rural life by the market economy, water mills steadily declined in usefulness and importance. With the farm population more than doubling from 1840 to 1880, the number of gristmills and sawmills in this country decreased by about 10 percent, from some 55,000 to 50,000. Except for the relatively small proportion of these mills driven by draft animals . . . or by wind . . . , the country mills were driven by the energy of falling water." [From *A History of Industrial Power in the United States, 1780–1930*, vol. 1. Photograph by John O. Brostrup, Historic American Buildings Survey Collection, Library of Congress]

countered by 19th-century Americans in using water as a source of industrial power.

Hunter covers such diverse topics as rainfall, streamflow, topography and soil conditions, water rights, the management of water resources, patterns of industrial location, and regional variations in water supply and use. It is his analysis of waterwheel development that is of particular interest, however. Instead of jumping from traditional waterwheels directly to modern turbines, he turns to study the complex relationships between impulse and reaction wheels and the transitional part they played in the evolution of waterpower. Here he concentrates on the contribution of the Americans Calvin Wing, Zebulon Parker, and Samuel Howd to the development of turbine engineering in the 1820's and 1830's.

Hunter continues by documenting the entry of the outward-flow Fourneyron turbine into America through the writings and experiments of the Philadelphia engineer Ellwood Morris and the introduction of Jonval's axial-flow turbine by the immigrant engineer Emile Geyelin. After discussing the installation of these early French wheels in the eastern United States, Hunter turns to the work of the Yankee hydraulic engineers Uriah Boyden and James Francis in New England during the 1840's and 1850's. He then moves on to the development of the American mixed-flow turbine and the emergence of turbines made to stock or standard patterns that could be adapted inexpensively to a variety of applications. He ends his book by tracing the declining use of waterpower and growing reliance on steam as a source of industrial power.

The book is constructed from a careful, detailed study and evaluation of the written sources. But there is more to the history of waterpower than can be found in the written record, for early millwrights and engineers did not take the time to record their work carefully and thoroughly on paper. To find the sort of evidence needed for detailed technological analysis of the traditional vertical waterwheels or the impulse and reaction wheels that were so important to the development of the true turbine, researchers are now turning to the artifacts themselves. Though much of the information thus obtained is still too new and too scattered to be reliable, these efforts provide valuable additions to the traditional documentation of the historian. Hunter's book, with its excellent overview of the history, economics, and sociology of 19th-century waterpower, provides industrial archeologists with a powerful conceptual framework for the evaluation of waterwheel remains that has been lacking in their studies. Moreover, it is a pleasure to read both for its easy style and for its erudition.

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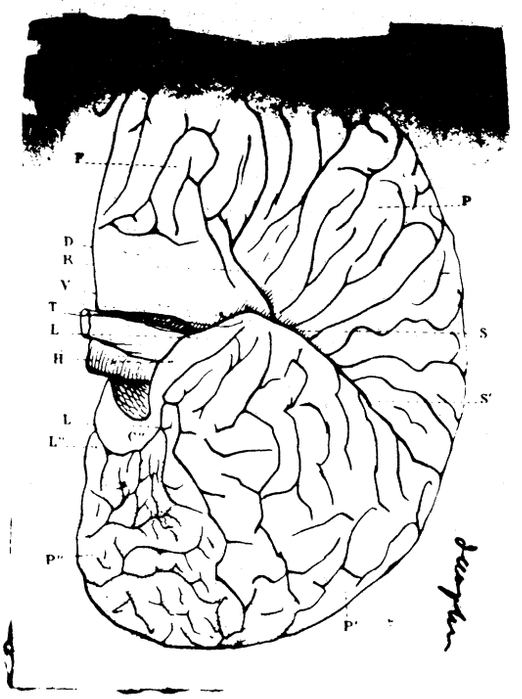
Life of an Anatomist

Paul Broca. Founder of French Anthropology, Explorer of the Brain. FRANCIS SCHILLER. University of California Press, Berkeley, 1980. x, 350 pp., illus. $25.

Paul Broca (1824–1880), one of France's most outstanding medical scientists and practitioners, was a pioneer of cerebral localization, a founder of anthropology, and the author of over 500 publications on these and related topics. His name is associated with one of the brain's speech centers, "Broca's area," and with the motor disturbance of speech, "Broca's aphasia," due to a lesion of that area and has other eponymous associations including a hospital and a street in Paris. He was a typical 19th-century polymath and much involved with the social upheavals of his time.

It is, therefore, surprising that Schiller's study is the first biography of him. Judging by its excellence there will be no need for another for many years. Schiller writes with scholarly charm, and being a neurologist he is especially well equipped to deal with the neurological aspects of his subject's work. He has based the book on wide reading, on Broca's correspondence, and on interviews with his descendants. It contains



A page from Broca's manuscript on the olfactory center, showing his drawing of the brain of a dolphin, inferior surface of left hemisphere. "As the prototype [for his comparative studies of the olfactory center] Broca used the brain of the otter, for it occupies an intermediate position between the osmatic and anosmatic type of great limbic lobe. The aquatic mammals, e.g. the dolphin family, occupy the extreme end of the series. In them the olfactory apparatus is non-existent: 'everything has disappeared, not only the olfactory lobe, but even the olfactory nerve fibers. . . . Their hippocampal lobe [H] is reduced to a minimum . . . and even smaller than in the primates . . . an olfactory desert.'" [*Mémoires d'Anthropologie de Paul Broca*, vol. 5, p. 334 (1888); reproduced in *Paul Broca*]